Pilot specification for implementation by change order on selected 2007 projects. Regions may modify this language based on their level of experience with GPS technology. For details regarding implementation contact Ken Brockman (kenneth.brockman@dot.state.wi.us) at 608-266-0279.

Construction Staking Subgrade, Item 650.4500; Construction Staking Initial Layout, Item 650.9900

Conform to standard spec 650 as modified in this special provision.

Replace standard spec 650.3.3 with the following:

650.3.3 Subgrade

650.3.3.1 General

(1) Use global positioning system (GPS) machine guidance or conventional subgrade staking on designated portions of the contract as follows:

GPS Machine Guidance	Subgrade Staking

(2) The engineer may require the contractor to revert to conventional subgrade staking methods for all or part of the work at any point during construction if, in the engineer's opinion, the GPS machine guidance is producing unacceptable results. If the engineer revokes approval to use GPS machine guidance on all or part of the work for reasons beyond the contractor's control, the department will measure the additional subgrade staking required to successfully complete the work in those areas as specified in 650.4(2) of this special provision.

650.3.3.2 Subgrade Staking

(1) Set construction stakes or marks at intervals of 100 feet, or more frequently, for rural sections and at intervals of 50 feet, or more frequently, for urban sections. Include additional stakes at each cross-section as necessary to match the plan cross-section, achieve the required accuracy, and to support construction operations. Also set and maintain stakes as necessary to establish the horizontal and vertical positions of intersecting road radii, auxiliary lanes, horizontal and vertical curves, and curve transitions. Locate stakes to within 0.25 feet (75 mm) horizontally and establish the grade elevation to within 0.03 feet (10 mm) vertically.

650.3.3.3 GPS Machine Guidance

650.3.3.3.1 General

(1) No subgrade stakes are required for work approved for GPS machine guidance.

(2) Coordinate with the engineer throughout the course of construction to ensure that work performed using GPS machine guidance conforms to the contract tolerances and that the methods employed conform to the contractor's GPS work plan and accepted industry standards. Address GPS machine guidance issues at weekly progress meetings.

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(3) Provide GPS rover equipment to department staff as requested to check the work. This equipment is not intended for exclusive use of the department and may be used by the contractor as needed on the project. Provide training for department staff designated to use the GPS rover. Training shall include but not be limited to hardware, software, and operation of GPS rover equipment. Provide a copy of the user manual for the supplied rover equipment. Provide routine maintenance of equipment provided for department use. The department is responsible for loss of, or damage (beyond normal wear and tear) to, the rover while in the engineer's possession.

650.3.3.3.2 GPS Work Plan

(1) Submit a comprehensive written GPS work plan for department review at least 10 business days before affected grading operations begin. The engineer will review the plan to determine if it conforms to the requirements of this special provision.

(2) Construct the subgrade as the contractor's GPS work plan provides. Update the plan as necessary during construction of the subgrade.

(3) The GPS work plan should discuss how GPS machine guidance technology will be integrated into other technologies employed on the project. Include, but do not limit the contents to, the following:

1. Describe the manufacturer, model, and software version of the GPS equipment.
2. Provide information on the qualifications of contractor staff. Include formal training and field experience. Designate a single staff person as the primary contact for GPS technology issues.
3. Describe how project control is to be established. Include a list and map showing control points enveloping the site.
4. Describe site calibration procedures. Include a map of the control points used for site calibration and control points used to check the site calibration. Describe the site calibration and checking frequency as well as how the site calibration and checking information are to be documented.
5. Describe the contractor's quality control procedures. Describe procedures for checking, mechanical calibration, and maintenance of equipment. Include the frequency and type of checks performed to ensure that the constructed subgrade conforms to the contract plans.

650.3.3.3.3 Equipment

(1) Use GPS machine guidance equipment to meet the requirements of the contract.

(2) Perform periodic sensor calibrations, checks for blade wear, and other routine adjustments as required to ensure that the final subgrade conforms to the contract plans.

650.3.3.3.4 Geometric and Surface Information

650.3.3.3.4.1 Department Responsibilities

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(1) The department will provide to the contractor the best available electronic files of survey and design information as described here in 650.3.3.3.4.1 and in CMM 3-1-10. The department incurs no additional liability, beyond that specified in standard spec 105.6 or standard spec 650, by having provided this additional information.

(2) The department will provide data to the contractor that include the following:

Data Type	Format
Reference Line Data	LandXML
Design Profile Data	LandXML
Proposed Cross Section Data	Land XML
Existing Surface DTM Data	LandXML DTM
Existing Topographic Data (excluding utilities)	LandXML
Superelevation Data	LandXML
Graphical Information	DGN or DWG

(3) The department will provide design surface data in the form of points and break lines derived from the cross sections in the contract in LandXML format. The points and break lines will be on the subgrade surface between the subgrade shoulder points, and will be on the finished surface in topsoiled areas. The department provides design surface data for information only, and has no contractual liability for it.

650.3.3.3.4.2 Contractor Responsibilities

(1) Develop and maintain the initial design surface DTM for areas of the project employing GPS machine guidance consistent with information the department provides. Confirm that the design surface DTM agrees with the contract plans.

(2) Provide design surface DTM information to the department in LandXML or other engineer-approved format.

650.3.3.3.4.3 Managing and Updating Information

(1) The department and contractor will agree on the design surface model before using it for construction. Provide a copy of the resultant design surface DTM to the engineer at least two business days before using that design surface DTM for construction.

(2) Notify the department of any errors or discrepancies in department-provided information. Provide information regarding errors or discrepancies in the existing surface DTM, identified in the field, to the department in LandXML format if a revision to the contract plans is required. If surveying work beyond that required to slope stake is required to re-define the existing surface, the department will pay for costs of that additional surveying as extra work.

(3 The department will determine what revisions may be required. The department will revise the contract plans and existing surface DTM, if necessary, to address errors or discrepancies that the contractor identifies. The department will provide the best available electronic files and other available information related to those contract plan revisions.

(4) Revise the design surface DTM as required to support construction operations and to reflect any contract plan revisions the department makes. Perform checks to confirm that the revised design surface DTM agrees with the contract plan revisions. Provide a copy of the resultant revised design surface DTM to the engineer. The department will pay for costs incurred to incorporate contract plan revisions as extra work.

(5) The department will maintain the existing surface DTM by incorporating needed revisions. The department will make the current existing surface DTM available, in LandXML DTM format, to the contractor throughout construction.

650.3.3.3.5 Site Calibration

(1) Designate a set of control points, including a total of at least 6 horizontal and vertical points or 2 per mile, whichever is greater, for site calibration for the portion of the project employing GPS machine guidance. Incorporate the department-provided control framework used for the original survey and design.

(2) Calibrate the site by determining the parameters governing the transformation of GPS information into the project coordinate system. Provide the resulting site calibration file to the engineer before beginning subgrade construction operations.

(3) In addition to the site calibration, perform site calibration checks. Perform these checks at individual control points not used in the initial site calibration. At a minimum, check the calibration at the start of each day and at least once for every 5 hours of continuous subgrade construction work. Report out-of-tolerance checks to the engineer. The measured position must match the established position at each individual control point within the following tolerances:

- Horizontally to 0.10 feet or less.
- Vertically to 0.05 feet or less.

(4) Provide the previous week's daily calibration check results to the engineer at the weekly progress meeting for monitoring the GPS work.

(5) The department will use the same calibration file the contractor uses.

650.3.3.3.6 Construction Checks

(1) Conduct calibration checks daily conforming to 650.3.3.3.5 of this special provision and consistent with the contractor's GPS work plan. Use a GPS rover to check the subgrade at

20 or more randomly selected locations per mile. Document all GPS rover subgrade checks and any auxiliary checks made using other technologies. Provide all documentation to the engineer.

(2) Ensure that at least 4 of any 5 consecutively-tested subgrade points are within 0.10 foot vertically of the plan elevation. Notify the engineer if more than one of any five consecutively-tested subgrade points differs by more than 0.10 feet from the plan elevation.

(3) The department will conduct periodic independent subgrade checks using the contractor supplied GPS rover or conventional survey methods. When using the GPS rover, the department will use the same calibration files and other hardware and software settings the contractor uses for subgrade checking. The department will notify the contractor if any individual check differs by more than 0.10 feet from the design.

Replace standard spec 650.3.12 with the following:

650.3.12 Initial Layout

(1) Set and maintain construction marks as required to support the method of operations consistent with third-order, class I horizontal and third-order vertical accuracy. Validate the department-provided horizontal and vertical control information and notify the engineer of any discrepancies. Provide marks to establish and maintain intermediate vertical and horizontal control for reference line alignment, side road alignments, radius points, bench level circuits, slopes on the ground, and offsetting the horizontal roadway alignment. These marks constitute the field control used to govern and execute the work.

(2) For the portion of the project using GPS machine guidance, set and maintain supplemental control points sufficient to ensure that there are a minimum of 6 established control points per mile. Ensure that these control points are consistent with third-order, class I horizontal and third-order vertical accuracy. Establish vertical control by differential leveling.

(3) Verify the existing ground elevations as shown for all roadways on cross-section sheets for accuracy. If the elevation at the slope intercept is off by more than 0.4 foot (120 mm), notify the engineer. Take and document a minimum of 3 shots per roadway section. Set and maintain slope stakes on each side of the road at each cross-section location shown on the plans. Stake additional clearing and grubbing, and marsh excavation limits at locations where they vary from the slope stakes.

(4) Document and provide to the engineer complete descriptions and reference ties for the control points, alignment points, and benchmarks to allow for quick reestablishment of the plan data at any time during construction and upon project completion.

Replace standard spec 650.4 with the following:

650.4 Measurement

Pilot specification for implementation by change order on selected 2007 projects. Regions may modify this language based on their level of experience with GPS technology. For details regarding implementation contact Ken Brockman (kenneth.brockman@dot.state.wi.us) at 608-266-0279.

(1) The department will measure the Construction Staking bid items for base, concrete pavement, resurfacing reference, and initial layout by the linear foot acceptably completed, measured along each roadway centerline. The department will not measure construction staking for base underlying concrete pavement.

(2) The department will measure Construction Staking Subgrade by the linear foot of subgrade acceptably completed, measured along each roadway centerline. The department will base measurement on the length of acceptably completed subgrade whether that subgrade was constructed using GPS machine guidance or using conventional construction staking. The department will include the length of subgrade where GPS machine guidance is initially employed but subsequently suspended by the engineer for reasons beyond the contractor's control. The department will measure this work twice, once for the suspended GPS work and once for the conventional subgrade staking required to successfully complete the work. If the department suspends GPS work for reasons within the contractor's control, the department will measure work in the affected area only once.

(3) The department will measure Construction Staking Curb Gutter and Curb & Gutter by the linear foot acceptably completed, measured along the base of the curb face. The department will measure Construction Staking Concrete Barrier by the linear foot acceptably completed, measured along the base of the barrier. The department will not measure these bid items if abutting concrete pavement.

(4) The department will measure Construction Staking Storm Sewer System as each individual inlet catch basin, manhole, and endwall acceptably completed.

(5) The department will measure Construction Staking Pipe Culverts by each individual pipe culvert staked and acceptably completed.

(6) The department will measure Construction Staking Structure Layout as a single lump sum unit for each structure acceptably completed. The department will measure Construction Staking Electrical Installations as a single lump sum unit for all electrical installations acceptably completed on each project.